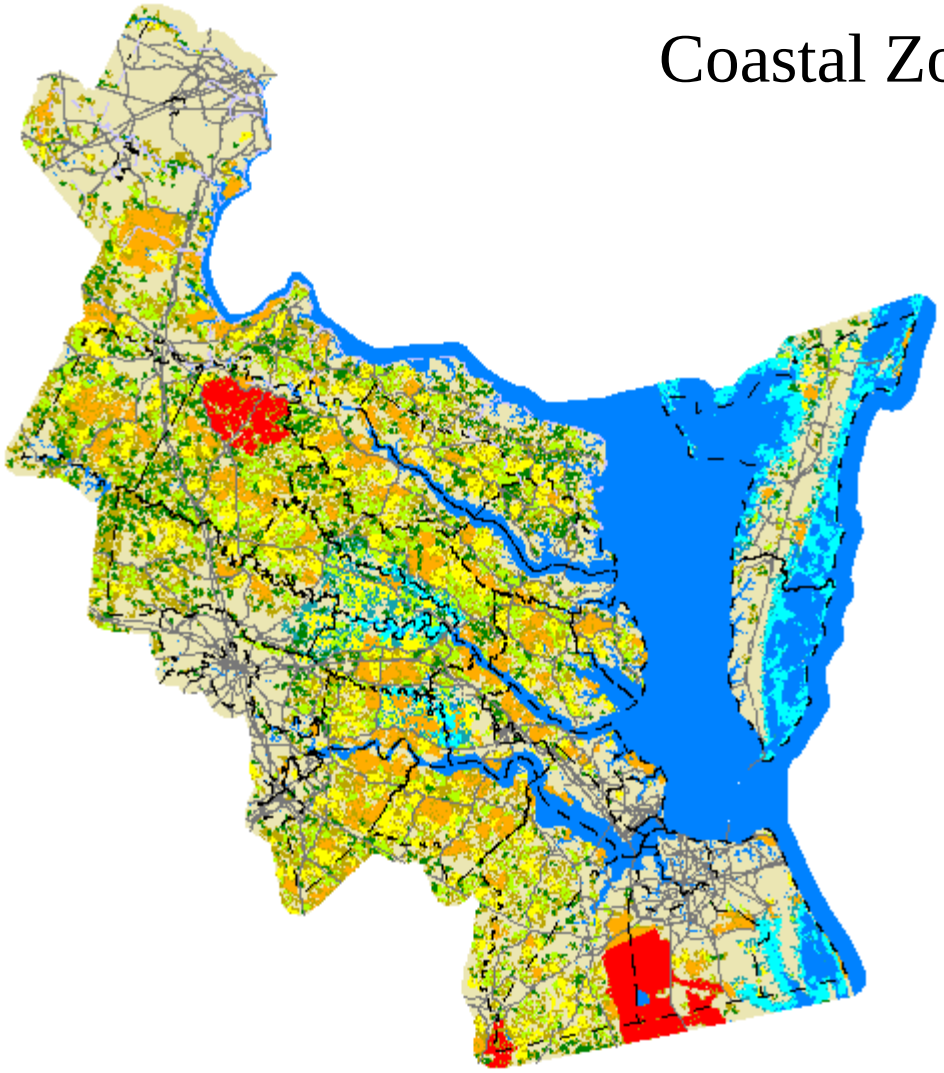
COMMONWEALTH of VIRGINIA

Virginia Conservation Lands Needs Assessment
Natural Landscape Assessment

Coastal Zone Atlas



Joseph T. Weber and Steven Carter-Lovejoy
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CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

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Virginia Department of Conservation and Recreation
Virginia Natural Heritage Program
217 Governor Street
Richmond, Virginia 23219
804-786-7951

By
Joseph T. Weber
GIS Projects Manager

And
Steven Carter-Lovejoy
Natural Heritage Information Manager

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VCLNA Natural Landscape Assessment
Coastal Zone Atlas

Table of Contents

Updated information about the VCLNA is available at http://www.dcr.state.va.us/dnh/vclna

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PROJECT DESCRIPTION

The Virginia Conservation Lands Needs Assessment (VCLNA)

The Virginia Conservation Lands Needs Assessment (VCLNA) is an analysis that uses GIS techniques to model and map priority conservation lands in Virginia. The VCLNA is a flexible tool for integrating and coordinating the needs and strategies of different conservation interests.

The VCLNA allows the manipulation of issue-specific data sets that can be weighted and overlaid to reflect the needs and concerns of a variety of conservation partners – issues like:

- unfragmented natural habitats
- natural heritage resources
- outdoor recreation
- prime agricultural lands
- cultural and historic resources
- sustainable forestry
- water quality improvement
- drinking water protection

There are a number of potential uses for the VCLNA. It can be used to direct land protection and acquisition for open space conservation, wildlife habitat, recreation, water quality protection, scenic view sheds, or historic and cultural resources. It can help to prioritize other resource management actions, such as invasive species control, and to identify priority potential restoration sites. The VCLNA can also provide data for local and regional governments to facilitate their planning, including growth management planning.

The VCLNA is intended to work at multiple scales. Though it can identify priorities at a Coastal Zone-wide level, it is also useful for local and regional partners to focus on conservation lands in specific areas, such as counties and watersheds. When implementing a conservation plan using the VCLNA partners can incorporate local data, including aerial photography, zoning overlays, land ownership, and land prices, and re-rank priorities based on local concerns and opportunities.

Habitat Loss and Fragmentation

According to the Virginia Conservation Network, "between 1992 and 1997, Virginia lost 343,500 acres to development. If current trends continue, Virginia will develop more land in the next 40 years than it has in the past 400 years." The scattered pattern of modern development consumes an excessive amount of land and fragments the landscape, destroying wildlife habitat and migration corridors. Development also degrades water quality and otherwise diminishes ecosystem functions.

Habitat loss is the greatest threat facing Virginia's biodiversity. As patches of habitat are lost, there is a direct reduction in the area of available habitat. When patches that are lost contain habitat unique to the area, there is also a reduction in habitat diversity and a reduction in populations dependent upon that habitat type.

Fragmentation is a natural consequence of habitat conversion, but current development patterns exacerbate the amount of habitat fragmentation taking place. Dividing a large patch into smaller patches, for example through conversion of some of the habitat to anthropogenic land uses, or imposition of barriers to dispersal such as roads, disproportionately removes interior habitat, reduces

population sizes, and reduces the diversity of species dependent on interior habitat conditions. As forests and wetlands are divided and isolated, interior habitat decreases and human disturbance increases. Opportunistic (and generally more common) edge species replace species dependent on interior habitat. Populations in isolated habitats face an increased probability of inbreeding and loss of fitness, as genetic exchange between isolated populations of interior species decreases. Furthermore, populations of many species in small habitat fragments become too small to persist. Even in habitat patches large enough to generally sustain interior species, population reduction or extirpation may occur due to short-term events or random fluctuations in population size, and the farther a habitat patch is from other patches containing populations of interior species, the less likely it is to be re-colonized.

Sometimes a patch of habitat can be in a key location, providing connectivity between other patches. When such a key patch is removed, not only can the individual organisms directly associated with that patch be lost, but there may also be local extinctions in patches that were dependent upon the lost patch for connectivity to additional habitat.

Thus large, unfragmented patches of natural vegetation have benefits that exceed the benefits of equivalent acreage of natural cover in several separate chunks. In addition to sustaining viable populations of interior species, providing core habitat and escape cover, and reducing extirpation probabilities, large expanses of natural vegetation also permit natural disturbance regimes and protect aquifers and streams.

The VCLNA Natural Landscape Assessment

The VCLNA Natural Landscape Assessment (NLA) is a landscape-scale GIS analysis for identifying, prioritizing, and linking natural habitats in Virginia. Using land cover data derived from satellite imagery, the NLA identifies unfragmented natural habitats called cores. Cores are prioritized according to their ecological value, notably their value as habitat for interior-dependent species, though they provide habitat for a wide range of species. Seven key wetland areas containing large clusters of estuarine or marine wetland cores are highlighted as wetland core clusters. Cores and wetland core clusters are supported and buffered by natural landscape blocks, which are aggregations of cores and adjacent natural habitat. The NLA also identifies corridors that connect and support the highest priority cores.

The Natural Landscape Assessment is a fundamental data layer for conservation in Virginia, one that readily complements other conservation interests and needs, but it is not a tool for fine-scale analyses and prioritizations. The NLA is one component of the more comprehensive VCLNA, but it offers a graphical vision of natural habitat status and needs in Virginia - a visual, attractive way to appeal to and inform the general public.

The Chesapeake Bay Program, through the Resource Lands Assessment Task Force, has completed a first-cut “Resource Lands Assessment” for the Chesapeake Bay region, including Virginia. This Assessment has several components:

- Ecological Assessment
- Water Quality
- Forest Economics
- Agricultural Economics
- Cultural
- Vulnerability

The Ecological Assessment roughly corresponds to the VCLNA Natural Landscape Assessment, and the other components suggest some obvious directions for further expansion of the VCLNA. One drawback to the Chesapeake Bay Program's Habitat Layer is that it is uses a land classification based on 1992 satellite imagery.

In the summer of 2002, the Virginia Coastal Program began assisting the Department of Conservation and Recreation in the work of taking responsibility for the Virginia portion of the Chesapeake Bay Program Resource Lands Assessment, updating and customizing it to meet the specific needs of Virginia and Virginia's Coastal Partners. This Atlas and accompanying data disk are one of the results. Additional support was provided by the Virginia Land Conservation Foundation and the Virginia Department of Conservation and Recreation.

METHODS

Study Area

The study area includes the coastal zone of Virginia, comprised of the localities that touch tidal waters, and a three-mile buffer around the coastal zone. The buffer was necessary to prevent truncation of VCLNA features that cross the coastal zone boundary.

Base Imagery

National Land Cover Data 2001 were obtained for USGS Mapping Zone 60, which covers Virginia's entire coastal zone, except for a portion of Chesterfield County. Despite the name, the NLCD 2001 product for zone 60 was derived from Landsat Thematic Mapper imagery acquired entirely in the year 2000. The zone 60 product had 13 classes: one each for water and barren; four for developed; two for agricultural; two for wetland; and three for forest cover types. No formal accuracy assessment was included with the imagery, but a layer of classification confidence was provided that indicated high accuracy for the imagery, since 84% of the pixels had classification confidences of at least 75%.

While the NLCD 2001 was fairly accurate, it did contain errors that would have negative impacts upon the VCLNA results. There were marshes and maritime grass communities that were misclassified as agriculture. The misclassified marshes were reclassified using unmodified wetlands from NWI data, while the misclassified maritime grasses were corrected by reclassifying pixels within dune areas that were known not to contain agriculture. The latter reclassifications resulted in an additional natural-cover class.

Cores Development

The corrected NLCD 2001 was used to develop the VCLNA cores, which are natural areas containing at least 100 acres of interior cover, that are bounded by anthropogenic land cover. Interior conditions begin 100 meters from manmade edges. Due to the 30-meter resolution of the NLCD 2001, some types of fragmentation were not visible in the imagery. In order to better approximate the true fragmentation in the landscape, a fragmentation layer was developed, which included spatial data about roads, railroad tracks, power lines, and pipelines. This layer was merged with the corrected NLCD 2001 to create a new image with values of "no data" for the pixels that intersected features of the fragmentation layer. The natural cover types, i.e. the forests, wetlands, and barrens, were extracted from the fragmented land cover image to produce a natural land cover layer. One pixel width of near-shore open water was added back into the layer, because these areas provide habitat for amphibians and other species that use this type of edge. The resulting layer constituted the "natural land" base layer for the analysis.

The interior areas of the patches in the natural land layer were identified. These areas are defined as those greater than 100 meters from manmade edges. Interior areas greater than or equal to 100 acres were then identified, and all patches not meeting this criterion were excluded from further analysis. The 100-meter transition zone used to identify interior areas was added back to the remaining interior areas to produce the final cores.

Peer review of an earlier version of the cores layer revealed concern that water was used to separate estuarine wetland cores. In reality water can act to unify rather than divide adjacent wetland areas. Estuarine wetland cores united by water probably function as a single landscape unit for many species. As a result of this review, we identified 7 key wetland areas that contain large clusters of estuarine or marine wetland cores. Within each area of clustered wetland cores, we merged together all wetland

cores contiguous with the water body of interest and all other wetlands adjacent to the water body to produce the wetland core clusters.

Core Prioritization Model

The cores development process identified the largest patches of unfragmented habitat in the coastal zone. While this information is valuable in itself, land managers need to know which cores are the highest conservation priorities if they are going to protect important habitats with limited resources, before those habitats are lost to development. The VCLNA Core Prioritization Model (below) was designed to give more weight to the most ecologically significant cores, thus flagging them as higher priorities for conservation.

The cores were compared and ranked for significance based upon the ecological and environmental parameters in the model illustrated in the figure on page 6. Weights were assigned to each parameter according to its importance. The model was reviewed by professionals from the Department of Conservation and Recreation, the Department of Game and Inland Fisheries, the Department of Environmental Quality, and Virginia Tech. Parameters were added and weights were adjusted based upon reviewer's comments.

This analysis was a coarse-scaled prioritization dependent upon statewide datasets. Due to data availability and the statewide scope of this model, only 29 of the 32 parameters were used for the coastal zone. The prioritization process excluded wetland core clusters, which are highly important, but since they were developed with different methodology, they are not directly comparable with cores.

The following paragraphs provide brief descriptions of and justifications for each parameter in the model, organized by category.

Species and Habitats include element occurrence records, conservation sites, and threatened and endangered waters. Element occurrences are point locations where rare species have been documented. Conservation Sites are a tool for representing key areas of the landscape worthy of protection and stewardship action because of the natural heritage resources and habitat they support. Conservation Sites are polygons built around one or more rare plant, animal, or natural communities designed to include the element and, where possible, its associated habitat, and buffer or other adjacent land thought necessary for the element's conservation. Stream Conservation Units (SCUs) identify stream reaches that contain aquatic natural heritage resources, including upstream and downstream buffer and tributaries associated with this reach. Combined with the SCUs in this category were Threatened and Endangered Waters data, provided by DGIF, which identify waters of the state with documented occurrences or T&E species. Conservation Sites and SCUs (and for this analysis, T&E Waters) have a biodiversity significance ranking based on the rarity, quality, and number of natural heritage resources they contain. The significance rankings are as follows: B1 - outstanding significance; B2 – very high significance; B3 – high significance; B4 – moderate significance; and B5 – general biodiversity significance.

Size of Interior refers to interior natural area within cores. Larger cores provide more interior conditions than smaller cores, thus they provide better and more protected habitats for species requiring these conditions. The weighting scheme is designed to give higher weight to the larger core areas.

VCLNA CORE PRIORITIZATION MODEL

Parameter	Weight	% of Total	Category % of Total
Rare Species and Habitats			50.5
Number of element occurrences in core (excluding low-precision & outdated EOs)§	15	5.9	
Area of B1 & B2-ranked terrestrial Conservation Sites in core	45	17.8	
Area of B3-ranked terrestrial Conservation Sites in core	15	5.9	
Area of B4-ranked terrestrial Conservation Sites in core	10	4.0	
Area of B5-ranked terrestrial Conservation Sites in core	5	2.0	
Length of B1 & B2-ranked Stream Conservation Units and T&E Waters in core	22.5	8.9	
Length of B3-ranked Stream Conservation Units and T&E Waters in core	7.5	3.0	
Length of B4-ranked Stream Conservation Units and T&E Waters in core	5	2.0	
Length of B5-ranked Stream Conservation Units and T&E Waters in core	2.5	1.0	
Size of Interior			10.7
Interior of core greater than or equal to 10,000 acres	15	5.9	
Interior of core from 5,000 to 9,999 acres	9	3.6	
Interior of core from 1,000 to 4,999 acres	3	1.2	
Wetlands			3.2
Area of NWI unmodified wetlands in core	8	3.2	
Diversity			9.1
VAGap Species Richness in core (above average only, index = mean+mode+median+maximum)	15	5.9	
Variety of NWI unmodified wetland in core	4	1.6	
Topographic relief index (standard deviation of elevations in core)	4	1.6	
Stream Quality			13.1
Aquatic Gap Species Richness in core*	15	5.9	
Modified Index of Biotic Integrity (Mini MIBI, includes only fish and mussels)**	6	2.4	
Length of streams within interior forest in core	6	2.4	
Length of confirmed anadromous fish reaches in core	3	1.2	
Length of potential anadromous fish reaches in core	2	0.8	
Length of streams containing natural brook trout populations in core	1	0.4	
Core Context			11.9
Area of core proximity zone divided by core area (measure of core isolation) ***	10	4.0	
Mean distance from core to nearest roads	6	2.4	
Proportion of core proximity zone made up of Natural Landscape Block	6	2.4	
Area of proximity to Wetland Core Cluster	4	1.6	
Nearest neighboring core distance ***	2	0.8	
Surrounding 100 meter buffer suitability index	2	0.8	
Fine Scale Habitats			1.6
Number of 1° & 2° dune occurrences in core	1	0.4	
Area of Critical or Special Neotropical Migratory Bird Habitat in core	1	0.4	
Area of karst geology in core	1	0.4	
Area of diabase geology in core	1	0.4	
Total:	252.5	100.0	100.0

Note: Higher parameter values carry more weight, except as indicated.

§ Excluding minutes and general precision, and records with last observation prior to 1980

* Data not currently available, but their use is anticipated for future iterations.

** This parameter will be replaced by a thorough stream assessment currently being developed by VCU. The new database will be more comprehensive and have higher resolution than the Mini MIBI, thus it will garner a much higher weight (15?).

*** Lower values carry more weight for these parameters.

Wetlands include unmodified wetlands from NWI data. Wetlands are important habitats for many species and the number of unmodified wetlands is declining, making their protection even more important.

Diversity consists of different measures of species diversity, with some environmental variables used as surrogates for species diversity. The Virginia Gap Analysis (VAGAP) species richness layer was developed using species distribution models based upon remotely sensed vegetation communities, and other habitat variables, to predict species richness. Variety of different NWI unmodified wetland types found within a core can be an indictor of diversity since, theoretically, a variety of wetlands would provide habitat for a greater variety of plants and animals. The topographic relief index is a measure of the variability of elevations within a core. Greater variability of elevations within a core indicates a greater variety of potential habitats within that core, which corresponds to a greater diversity of organisms.

Stream Quality includes parameters that indicate species diversity and the quality of streams. The Aquatic Gap Species Richness data were not available at the time the core prioritization was being conducted. The Modified Index of Biotic Integrity (MIBI), developed by VCU, contains records for fish and mussels only; it indicates a watershed's biotic integrity by summarizing records for rare and sensitive species, as well as tolerant, exotic, and invasive species (indicators of pollution and disturbance). Streams within interior forest are generally cooler, less disturbed, and they contain more sensitive species than non-interior streams. Streams that are confirmed or potential reaches for anadromous fish are among the cleanest and least disturbed waters in the state according to DGIF biologists, thus they are indicators of high water quality. Brook trout also are an indicator of less disturbed streams with higher water quality, however, since brook trout do not occur in the coastal zone of Virginia, this parameter was not used for the coastal zone pilot study.

Core Context contains parameters that are indicators of core isolation and connection feasibility, as well as indicators of proximity to disturbance. Area of proximity zone divided by core area is a measure of core isolation that measures the space between a core and a location equidistant to all the cores that immediately surround it. Larger proximity zones denote isolated cores that would need longer corridors to connect them to other cores, which would be less effective in terms of animal and pollen movement between cores. Mean distance from core to nearest road is an indicator of proximity to human disturbance. Cores that are further from roads provide more habitat for species that avoid or are negatively impacted by roads, therefore such cores should receive higher priority. The proportion of a core's proximity zone that is made up of natural landscape block is an indication of how much natural buffer surrounds a core, an important characteristic for long-term protection of sensitive species. Area of proximity to a wetland core cluster pertains to a core's importance to wetland core clusters by maintaining its connections to other landscape features. Nearest neighboring core distance is related to connection feasibility. Cores with close neighbors are typically easier to connect with corridors. Surrounding buffer suitability uses the land cover around cores as an indication of how well a core is protected from human related disturbances. For example, a buffer with a high percentage of forest would have a better score than one with a high percentage of roads.

Fine Scale Habitats includes special interest habitats that are localized within the state. Included in this category are primary and secondary dunes, karst geology, and diabase geology. These habitats represent a relatively small proportion of the landscape, yet they house a disproportionate number of rare species and high biodiversities. Also included in this category are critical and special neotropical

migratory bird habitats that have continental importance for conserving a large variety of birds during migration.

Core Score Calculations

The raw values (number, area, length, or index value, depending upon the parameter) for each parameter, derived from spatial analysis of the cores and parameter layers, were converted to parameter scores using the equation in Figure 1.

Figure 1. Equation used to calculate parameter scores for each core.

$$PS = \left[MW \times \left(CIP / TNC\right)\right] \times \left[RV / \sum RV\right]$$

where:

PS	=	parameter score
MW	=	model weight
CIP	=	number of cores intersecting parameter (for which the parameter was relevant)
TNC	=	total number of cores
RV	=	raw value
ΣRV	=	sum of raw values

A total score was calculated for each core by summing all the parameter scores. The total scores should be used for detailed comparisons of core value. For display purposes, the total scores were classified into five levels of core significance by the cumulative area of the cores. This was done by first identifying cores that were statistical outliers and assigning them to the highest category: C1, Outstanding Significance. All the remaining cores were sorted by total score and then assigned to categories so that 25% of the total core area, excluding the area of C1 cores, would be in each of the remaining categories, C2 through C5. These core significance values were used to display cores in the Prioritized Cores and Connecting Corridor maps.

Natural Landscape Block Development

Natural landscape blocks are natural areas containing one or more core areas, that are bounded by major roads and unsuitable land cover greater than 100 meters across. Natural landscape blocks were developed using natural land covers (mostly forests and wetlands) from the base imagery and eliminating areas of detected and estimated human disturbance (e.g. roads, residential areas, and other developed lands). The process involved buffering each patch in the natural land cover layer by 50 meters, thereby closing any 100 meter gaps, and then eliminating from the resulting layer any areas of coincidence with major roads, buffered developed lands derived from the NLCD 2001, buffered high-density road areas developed from a focal sum analysis of the VDOT roads layer, and buffered road intersections and terminuses developed from the VDOT roads layer. The interior areas of the resulting patches were identified and then only those interior areas that intersected cores were retained. The 100-meter edge transitions were added back in and "donut holes" less than 100 acres were patched to produce the final natural landscape blocks. The natural landscape blocks that intersected wetland core clusters formed a special category of natural landscape block called wetland cluster landscape blocks.

Corridor Development

Corridors are strips of natural cover, located generally in a matrix of unnatural land covers, that connect the highest-priority cores (i.e. C1 and C2 cores). Development of the corridors required least-cost-path analysis to identify the best corridor routes. The least-cost-path analysis involved a corridor suitability layer that was produced by using a model to combine various landscape parameters,

including land cover, urban proximity, riparian forest, roads, slope, core rank, interior forest, and offshore water. This layer represents impedances, that is, the degree to which landscape parameters inhibit wildlife use and movement. The suitability layer was used to create a cost-distance layer, the least-cost-paths between cores, which were used to produce the corridors. Corridors were further widened where they intersected lower-ranked cores, interior forests, and wetlands. These areas are called "nodes" and they serve as patches of habitat along the corridor routes.

Vulnerability Assessment

In this analysis we identified cores at greatest risk of being lost to development. A layer depicting development pressure was obtained from the Chesapeake Bay Resources Lands Assessment. Since this layer was developed only for the Chesapeake Bay watershed, it covered all of Virginia's coastal zone except for the southernmost and easternmost areas, which are in different watersheds. This layer was classified into four levels of development pressure ranging from low to high. The pixels representing high development pressure were extracted from this layer and intersected with the prioritized cores layer to identify those cores in proximity to the highest development pressure.

DEFINITIONS

Cores are patches of natural land cover (mainly forests and wetlands) with at least 100 acres of interior conditions. Interior conditions begin 100 meters inward from the patch edge. Cores are the least fragmented and most important VCLNA features.

Wetland Core Clusters are large groupings of estuarine or marine wetland cores that are connected by water and function as units.

Natural Landscape Blocks are slightly fragmented aggregations of core areas, plus contiguous natural land cover. Natural landscape blocks are natural lands that contain and buffer cores.

Wetland Cluster Landscape Blocks are Natural landscape blocks that contain wetland core clusters.

Corridors are strips of natural land cover that link cores, allowing animal, seed, and pollen movement between cores.

Corridor Nodes are patches of interior forest and wetlands, and lower-ranked cores, that intersect corridors. Nodes widen corridors and facilitate animal movement through corridors by providing suitable habitat along the way.

Vulnerable Cores are those cores and wetland core clusters that intersect areas of high development pressure.

Conservation Sites are designed to encompass natural heritage resource locations, their associated habitats, and buffers thought necessary for conservation of these resources. For rare aquatic species, Stream Conservation Units (SCUs) identify stream reaches that contain aquatic natural heritage resources, including upstream and downstream buffer and tributaries associated with this reach. Conservation Sites and Stream Conservation Units are given biodiversity significance ranks (B-ranks) based on the rarity, quality, and number of element occurrences they contain.

Conservation Lands are public and certain private lands that have potential significance for protecting a variety of conservation, recreation, and open-space roles.

DESCRIPTION AND DISCUSSION OF ATLAS MAPS

There is a separate Atlas, including its associated catalog, for each of the Planning District Commissions (PDC) in the Coastal Resources Management Area. There is also a comprehensive Atlas containing a copy of all of the maps that appear in each PDC Atlas, as well as a single catalog listing attributes of all of the cores identified in the Coastal Zone study area.

Coastal Zone Prioritized Cores and Connecting Corridors

Each Atlas contains a map of VCLNA Prioritized Cores and Connecting Corridors for the entire Coastal Zone study area. This map provides an overview of the distribution of natural landscape features across the entire Coastal Zone.

- Features on this map include:
    - prioritized cores (ranked C1-C5)
    - wetland core clusters
    - natural landscape blocks
    - wetland cluster landscape blocks
    - corridors for C1 and C2 cores
    - corridor nodes
- An inset shows the distribution of natural landscape blocks and wetland cluster landscape blocks that underlie, and thus in the main map are partially obscured by, the cores and wetland core clusters. Natural landscape blocks do not show up very prominently on the principal map with the cores. This is in part because they are displayed with a neutral color, because we did not want them to distract from the cores and wetland core clusters, which are of considerably greater conservation importance. But the natural landscape blocks are the matrix in which the cores and wetland core clusters are embedded, and they are likely to play a significant role in the design of effective corridors connecting cores.
- The color of each core represents its relative priority, from cores of outstanding ecological significance (C1) to cores of general significance (C5).
- The cores of outstanding and very high significance (red, C1 and orange, C2) are linked by corridors. The corridors, situated along routes that offer the minimum resistance to animals and plant propagules (according to the GIS model), are intended to suggest potential ways to link the highest priority cores. There are myriad other potential paths to link cores, using a variety of criteria.
- Corridors are designed as 300 meters in width, but when they intersect lower-ranked cores, interior forests, or wetlands identified through this analysis, those areas are highlighted with stippling and called nodes. The presence of nodes will enhance the potential success of a corridor.
- Due to size limitations, cores are not labeled with identification numbers on this map; identification numbers are only displayed on the PDC Prioritized Cores and Connecting Corridors maps.
- This analysis demonstrates a number of things, including:
    - Significant cores and wetland core clusters are scattered throughout the Coastal Zone.
    - Many areas of known conservation interest are not included in cores and wetland core clusters. The Natural Landscape Analysis is based on identification of interior habitats, and the cores identified had to meet the minimum size criterion of 100 acres of interior area (the smallest complete core is 168 acres). Many natural features of great local or statewide conservation interest, including areas with natural land cover that could be identified from the dataset we used, are not directly identified in the Natural Landscape

Assessment. This highlights the importance of assembling multiple datasets to enhance the value of the VCLNA as a comprehensive conservation tool.

Each PDC Atlas also contains each of the following maps:

PDC Prioritized Cores and Connecting Corridors

For each PDC there is a map of VCLNA prioritized cores and connecting corridors. (For PDCs that include counties outside of the Coastal Zone, only those counties that fall within the Coastal Zone are included in the analysis.) This map provides an overview of the distribution of natural landscape features within the PDC.

- Features on this map include:
  - prioritized cores (ranked C1-C5)
  - wetland core clusters
  - natural landscape blocks
  - wetland cluster landscape blocks
  - corridors for C1 and C2 cores
  - corridor nodes
- This map contains all of the features contained in the Coastal Zone-wide map.
- This map contains one additional element: Each of the cores is identified with a unique number that references corresponding attribute data for the core in the catalog following the maps.
- Many cores overlap between two or more PDCs. Identification numbers are repeated (on the map and in the catalog) in each PDC for such cores, unless the fragment in a specific PDC is no more than a few acres.
- This analysis demonstrates a number of things, including:
  - The proximity of another core or wetland core cluster, especially a core of high priority, can add value to a core or wetland core cluster being considered for conservation action.
  - Conversely, a core in an area with few or distant other cores or wetland core clusters might be more highly valued for consideration for conservation action.
  - Many areas of known conservation interest are not included in cores and wetland core clusters. The Natural Landscape Analysis is based on identification of interior habitats, and the cores identified had to meet the minimum size criterion of 100 acres of interior area (the smallest complete core is 168 acres). Many natural features of great local or statewide conservation interest are areas with less than this amount of natural land cover. This highlights the importance of assembling multiple datasets to enhance the value of the VCLNA as a comprehensive conservation tool.

PDC Vulnerable Cores and Wetland Core Clusters

Each PDC has a map displaying those VCLNA cores at greatest risk of being lost to development.

- Features:
  - only the cores and wetland core clusters (all ranks) that intersect areas of highest vulnerability as determined by intersection with the Chesapeake Bay Resource Lands Assessment (RLA) development pressure layer
  - conservation lands that intersect the vulnerable cores
  - an inset of the PDC shows just vulnerability, with four categories of color coding indicating the range of vulnerability from low to high development pressure

    - in 3 PDCs, where the RLA vulnerability analysis did not cover portions of the PDC outside the Bay's watershed, cores and wetland core clusters were not assessed for vulnerability; these cores are displayed in gray
- Cores and wetland core clusters that do not intersect an area of the PDC with the highest level of vulnerability are not displayed
- The conservation rank of the most vulnerable cores is displayed by color, so that attention can be focused on the most vulnerable cores with the highest significance
- Conservation lands that intersect the vulnerable cores are displayed because cores or portions of cores under these ownerships may not be as vulnerable as nearby cores, depending on the protection and management offered by the specific owners.
- The source of the vulnerability analysis was the Chesapeake Bay Program Resource Lands Assessment Workgroup, and these data were only available for lands in the Chesapeake Bay watershed. Therefore, in the three Coastal PDCs with study area land outside of the Chesapeake Bay watershed, not all cores and core wetlands could be evaluated against the vulnerability analysis data. These cores and core wetlands are displayed in gray on the maps, to make clear where the data are incomplete.
- The vulnerability analysis is based on past growth rates, and stratifies the land area into urban, suburban, and rural so that growth rates are compared for comparable land uses; in this way vulnerability of rural lands distant from metropolitan centers can be identified as well as the more obvious vulnerability of lands on the fringes of metropolitan centers.
- Myriad interacting factors determine the vulnerability of land to conversion from a natural to an anthropogenic land cover. A variety of vulnerability analyses could be designed to validly identify the most vulnerable cores; the technique used in this pilot is just an example.
- This vulnerability analysis, like most, identifies the potential for conversion from a natural land cover, but cannot predict with any certainty whether any particular tract of land will be converted.
- This analysis demonstrates a number of things, including:
    - Vulnerable cores and wetland core clusters are scattered throughout the Coastal Zone.
    - Numerous vulnerable cores are located in the most rural portions of the Coastal Zone.

PDC Current Conservation Lands and Intersecting Cores

Each PDC has a map of Conservation Lands and intersecting VCLNA cores and wetland core clusters.

- Features on this map include:
    - all conservation lands, color coded by type
    - only those cores and wetland core clusters that intersect conservation lands (cores are not displayed by rank)
- Conservation lands - public and certain private lands that have potential significance for protecting a variety of conservation, recreation, and open-space roles – are displayed with colors that indicate their ownership type.
- Cores are displayed in green and wetland core clusters in cyan, no matter what their relative significance, so that the focus can remain with conservation lands.
- Cores and wetland core clusters that do not intersect a conservation land are not displayed, but all conservation lands within the PDC are displayed.
- This analysis demonstrates a number of things, including:
    - This map can demonstrate the extent to which conservation lands protect significant core habitats

- Conservation lands that do not intersect cores are not displayed; these lands, though they may have value for a variety of other purposes, do little to protect cores.
- The proximity of a conservation land can add value to a core or wetland core cluster being considered for conservation action, and help to identify key conservation partners.
- Knowledge of the location of remaining cores and wetland core clusters can help conservation land managers to identify valuable opportunities for expansion and restoration.
- Existing conservation lands do not generally exist for the purpose of protecting cores and wetland core clusters, and may indeed be managed in ways that threaten these natural landscapes. This map can help target conservation lands whose proper management is important for the ongoing protection and enhancement of cores and wetland core clusters.

PDC Natural Heritage Conservation Sites and Intersecting Cores

Each PDC has a map of Natural Heritage Conservation Sites (including Stream Conservation Units (SCUs), if present), as well as just those VCLNA cores and wetland core clusters that intersect the Conservation Sites.

- Features on this map include:
  - all conservation sites, ranked by Brank
  - only those cores and wetland core clusters(not displayed by rank) that intersect conservation sites
- The Conservation Sites and SCUs are displayed with colors that represent their biodiversity significance ranks – from B1 (for sites with outstanding biodiversity significance, of global conservation significance) to B5 (for sites with general biodiversity significance).
- Cores are displayed in green and wetland core clusters in cyan, no matter what their relative significance, so that the focus can remain with Natural Heritage Conservation Sites.
- Cores and wetland core clusters that do not intersect a conservation site or SCU are not displayed, but all conservation sites and SCUs within the PDC are displayed. (Conservation Sites and SCUs do not all display well – some sites are small and SCUs are narrow, linear features.)
- This analysis demonstrates a number of things, including:
  - The proximity of a Conservation Site with natural heritage resource features can add value and priority to a core or wetland core cluster being considered for conservation action.
  - Similarly, the proximity of a core or wetland core cluster can add value and priority to a Conservation Site being considered for conservation action.
  - Many Conservation Sites are not located in or near cores or wetland core clusters. This is primarily because many natural heritage resources are not dependent on interior habitats. It also demonstrates that many highly significant conservation targets are not directly included in the Natural Landscape Assessment, and highlights the importance of assembling multiple datasets to enhance the value of the VCLNA as a comprehensive conservation tool.

DESCRIPTION AND DISCUSSION OF CATALOG

The Catalog is a list of all of the cores identified in this Natural Landscape Assessment – either (for the Comprehensive Atlas) all of the cores in the entire Coastal Zone study area, or (for each PDC) the cores that fall within this particular Coastal Planning District Commission.

Each core appearing on the PDC Prioritized Cores map is labeled with a unique identifying number corresponding to an entry in the catalog. Additional attributes appearing in the catalog are provided to facilitate comparison of different cores. These columns represent the key criteria that were used to assign a relative core significance rank to each core, following the methodology outlined elsewhere in this report. Within each column the values can be compared among cores to identify the relative contribution of the different criteria to the overall ranking of the core.

To assist with comparison of cores, the values in the catalog are transformed parameter scores rather than the raw values (see Figure 1). Each core's value represents its proportion of the total raw score for all cores.

Following is a listing of each column heading name in the catalog with a brief description of the attribute to which that heading refers. More description of the significance of these attributes is available in the Methods section. Unless otherwise indicated, higher raw values led to higher scores for each parameter.

COREID
: Unique identifier for core.

ACRES
: Acreage of core

COUNTY1, COUNTY2, COUNTY3
: Counties in which core is located. County1 is the county in which the largest amount of the core's acreage is located, County3 (if applicable) has the least.

PDC1, PDC2, PDC3
: PDCs in which core is located. PDC1 is the PDC in which the largest amount of the core's acreage is located, PDC3 (if applicable) has the least.

NUMEO
: Number of element occurrences of natural heritage resources (rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest) in the core. Low-precision (minutes and general precision) and historic records (last observation prior to 1980) were removed from the EO dataset before this parameter was generated.

B1B2CS
: Acreage of B1 and/or B2-ranked natural heritage conservation sites in the core. Conservation sites are areas that include the associated habitat of one or more occurrences of natural heritage resources as well as buffer and other land necessary for the element's conservation. B ranks indicate the biodiversity significance of a conservation site, based on the rarity, quality, and number of element occurrences it contains, and range from B1 (outstanding or global significance) to B5 (general significance). B1 and B2-ranked conservation sites were combined here because there is some subjectivity involved in the determination of whether a site should be a B1 or B2. Both ranks indicate highly important sites.

B3CS

Acreage of B3-ranked natural heritage conservation sites in the core.

B4CS

Acreage of B4-ranked natural heritage conservation sites in the core.

B5CS

Acreage of B5-ranked natural heritage conservation sites in the core.

B2SCU

Length of B2-ranked natural heritage stream conservation units and/or Threatened and Endangered Species Waters in the core. Stream conservation units (SCUs) identify stream reaches that contain aquatic natural heritage resources, including upstream and downstream buffer and tributaries associated with this reach. B ranks indicate the biodiversity significance of a SCU, based on the rarity, quality, and number of element occurrences it contains, and range from B1 (outstanding or global significance) to B5 (general significance). (There are no B1-ranked SCUs in the coastal zone.) The Threatened and Endangered Species Waters layer, obtained from DGIF, identifies and delineates the boundaries of stream reaches containing federal and state threatened or endangered aquatic species, limited to species inhabiting primarily lotic or riverine habitats including fish, mollusks, and the wood turtle. B ranks were assigned to these waters using natural heritage protocol.

B3SCU

Length of B3-ranked natural heritage stream conservation units or T & E waters in the core.

B4SCU

Length of B4-ranked natural heritage stream conservation units or T & E waters in the core.

B5SCU

Length of B5-ranked natural heritage stream conservation units or T & E waters in the core.

GT10000A

Total interior acreage, for cores with over 10,000 acres of interior cover

GT5000A

Total interior acreage, for cores with over 5,000 acres of interior cover

GT1000A

Total interior acreage, for cores with over 1,000 acres of interior cover

UNMODNWI

Area of National Wetland Inventory (NWI) unmodified wetlands in core

SPPRICH

Species Richness (diversity) in the core, according to the Virginia GAP Analysis. Only above average scores are counted; the index is calculated as mean+mode+median+maximum.

NWIVAR

Variety of National Wetland Inventory (NWI) unmodified wetlands in core

TOPOREL

Topographic relief index (standard deviation of elevations in core)

TMIBI

Total score for a core's watershed(s) from VCU's Modified Index of Biotic Integrity. This index includes records for fish and mussels only, and it indicates a watershed's biotic integrity by summarizing records for rare and sensitive species, as well as tolerant, exotic, and invasive species (indicators of pollution and disturbance).

FRSTREAM

Length of streams within interior forest in core

CONFISH

Length of confirmed DGIF anadromous fish reaches in core

POTFISH
: Length of potential DGIF anadromous fish reaches in core

COREPROX
: Area of core proximity zone divided by core area (a measure of core isolation). The core proximity zone is the area from the edge of the core to the nearest cores on all sides. Lower raw values led to higher final scores for this parameter.

ROADDIST
: Mean distance from core to nearest roads in the VDOT roads layer

NLBPROX
: Proportion of core proximity zone made up of natural landscape block

FWETPROX
: Area of proximity to wetland core cluster

NEARCORE
: Nearest neighboring core distance

SUITIND
: Suitability index of a 100 meter buffer surrounding the core

NMDUNES
: Number of primary and secondary dune occurrences in core

NEOTROP
: Area of Critical or Special Neotropical Migratory Bird Habitat in core

DIABASE
: Area of diabase geology in core

TOTSCOR1
: Total score--the sum of all the parameter scores. Higher scores indicate higher priorities.

CORERANK
: Core rank. These values range from 1 (C1--Outstanding Significance) to 5 (C5—of General Significance).

The data in this catalog are also available digitally on the accompanying disk.

OTHER DISCUSSION

Error in Fragmentation Coverage.
The fragmentation layer consists of roads, railroads, power lines, and pipelines, and was used along with anthropogenic land cover types to delineate patches of natural habitat. During the creation of this layer an artifact from the VDOT roads data, county boundaries, was included inadvertently and unnoticed. County boundaries often coincide with legitimate fragmenting features, especially bodies of water and roads; but boundaries that do not resulted in additional, incorrect fragmentation of natural land cover. The effects of this incorrect fragmentation are threefold:

- Some adjacent cores, incorrectly dissected by a county boundary that does not represent a fragmenting feature, should be consolidated, thereby creating a larger core with a greater size and relative rank among other cores.
- Some cores should incorporate adjacent areas of natural landscape block that were incorrectly separated from the core by a county boundary that does not represent a fragmenting feature, thereby increasing the size and potentially the relative rank of that core.
- Some new cores may need to be created from legitimately continuous natural landscape blocks that, if not dissected by a county boundary, would amass to exceed the 100 acre minimum interior area threshold for identifying cores.

This error was discovered only after the final product maps were created, and at the time of producing this report we do not know the full extent of the problem. Since the prioritization of cores is based on scores relative to other cores, a reassessment that changes the scores of cores that are enlarged or consolidated, or potentially creates new cores, will affect the relative standing of all cores. Changes in core priorities might or might not be substantial. We will continue to investigate the problem, and post updated information on the VCLNA website.

Wetland Core Clusters and Wetland Cluster Landscape Blocks
The concepts of wetland core clusters and wetland cluster landscape blocks were developed after peer review of an earlier version of the cores layer revealed concern about how water was used to separate estuarine wetland cores. In reality water can act to unify rather than divide adjacent wetland areas. Estuarine wetland cores united by water probably function as a single landscape unit for many species.

Wetland core clusters are useful in the way they identify a particular type of landscape element that differs considerably from most cores in their vulnerabilities and protection and management needs. But their presence poses some problems for the Natural Landscape Assessment too. The seven wetland core clusters were not identified through any quantitative technique, but according to the informed opinion of Department of Conservation and Recreation Natural Heritage staff. There are many other significant wetlands throughout the Coastal Zone, incorporated into standard cores, but their perception is potentially diminished by the wetland core clusters. Wetland core clusters and wetland cluster landscape blocks present two additional features that have to be evaluated along with other cores. Even though the seven wetland core clusters identified are widely recognized for their conservation values, and have already been the focus of considerable conservation activity, there is no quantitative way to compare wetland core clusters with other cores in the way that standard cores can be compared to each other.

The Maryland and Chesapeake Bay resource lands assessments distinguished among terrestrial, wetland, and aquatic cores. When the VCLNA Natural Landscape Assessment is expanded, we

anticipate developing a revised methodology that uses a similar concept to ensure that the value of wetlands can be more directly compared to the value of other conservation lands.

Vulnerability Analysis

Vulnerability is an important concept in prioritizing conservation activities, but because it is essentially a prediction of the future there are almost an unlimited number of reasonable analyses that could be developed. In this project we applied a relatively simple analysis that had already been made by Peter Claggett of EPA for the Chesapeake Bay Program; it saved time, and reduced likely second-guessing about vulnerability methodology. More iterations of the vulnerability analysis are needed to meet the needs of conservation planners. Other vulnerability models might use parameters such as:

- ownership, easement, and regulatory restrictions on development
- land management
- incentives for development
- population growth
- number of parcels in core
- commuting time to urban centers
- mean distance to nearest major road

The accuracy of one vulnerability analysis versus another shouldn't distract from the recognition that the future will be different and, at whatever rate in any particular area, development will continue to destroy and fragment the Virginia Coastal Zone's remaining habitat.

NEXT STEPS

Suggestions for use

We encourage people to review these products, to try to use them to accomplish conservation goals, and to consider ways in which they could be improved to accomplish current projects more effectively or to enable their use in future projects.

We encourage local and regional agencies and organizations to implement conservation actions using these data and analyses. As a robust, well-documented GIS model, the Natural Landscape Assessment can be creatively tweaked to offer practical uses for variety of needs. The ability to add data makes it an excellent framework for future development of protection and growth planning tools.

The Natural Landscape Assessment has some notable limitations because it is based upon land cover derived from Landsat Thematic Mapper imagery.

- The pixel size of this imagery is 30 meters by 30 meters, so small units are not identifiable. Thus the Natural Landscape Assessment is a landscape-level analysis and it is NOT a tool for identifying small patches of habitat that may be important.
- Land cover classifications are imperfect, and some land cover types (for example, natural grasslands) are very difficult to identify. Thus the Natural Landscape Assessment is NOT a tool for identifying natural grasslands.
- Acceptable accuracy levels of 80% or higher still mean that thousands of pixels are incorrectly characterized. Thus the Natural Landscape Assessment is NOT a tool for fine-scale analyses and prioritizations. However, the potential effects of many misclassifications were nullified by VCLNA procedures that aggregated all the natural land cover types in to a single natural cover class before VCLNA features were developed.
- Many key conservation features are not well correlated with identifiable land cover types. Thus the Natural Landscape Assessment is NOT a tool for prioritizing natural heritage resource protection lands.

The focus in the current products is on a regional scale, but the Natural Landscape Assessment can provide context and direction for a focus on conservation lands in specific areas, such as counties and watersheds. To increase the scale to be more locally relevant, local data can be incorporated with the Natural Land Assessment, including aerial photography, zoning overlays, land ownership, and land prices.

Remember that the Natural Landscape Assessment is designed for a specific target - natural lands with significant amounts of interior habitat. Additional datasets are needed to identify additional conservation targets, and to more effectively prioritize targets to reflect local interests. Priorities should be re-ranked based on local concerns and opportunities.

Even without making direct use of the GIS model and data, maps produced from the VCLNA can provide an organizational medium for planners to inform and engage the public at a variety of scales. Be sure to understand what data are and are not presented on each map.

The Natural Landscape Assessment has been carefully derived using the best available data, but keep in mind that this is a complex project still in the pilot phase. There are clearly problems with the

methodology - some of which we recognize and acknowledge in this report, others that we hope you will call to our attention.

Plans for the future of VCLNA.
With ongoing support from a number of partners, the Department of Conservation and Recreation is working in a variety of ways to further the utility of the VCLNA as a tool for integrating coastal and statewide conservation interests:

- The VCLNA Natural Landscape Assessment is being extended to the rest of the state, using a more detailed land classification and methodology improved by the experiences with the Coastal NLA pilot.

- In coordination with state agencies and conservation partners we are acquiring or developing complementary geospatial data sets to facilitate land conservation strategies that meet multiple objectives. These datasets will be accurately incorporated into an expanded, comprehensive VCLNA; they might include or address:
  - Spatially explicit sites identified as priorities through existing plans (such as Partners in Flight priority sites).
  - Local parks, local natural features (useful for Green Infrastructure identification)
  - Wildlife diversity (for State Wildlife Comprehensive Planning)
  - Recreational lands and identified recreation needs (for Virginia Outdoors Plan)
  - Forest use and forest economic data (for Sustainable Forestry decision-making)
  - Surface and subterranean drinking water sources (for drinking water protection)
  - Biotic and abiotic factors that influence stream water quality (for water quality protection and improvement)
  - Historic and cultural resource locations (for historic resource protection)
  - Prime agricultural lands (for Agricultural Reserves)
  - Growth measures (for vulnerability analyses)
  - Geospatial datasets developed through the Blue Infrastructure, ensuring that Blue Infrastructure protection needs are effectively addressed through the VCLNA

- We also plan to promote the application of the VCLNA in the Coastal Zone, working with localities, watershed protection groups, and other conservation organizations to use the VCLNA to focus on specific areas. We want to provide training and technical assistance, helping local and regional partners to incorporate local data with the VCLNA, including aerial photography, zoning overlays, land ownership, and land prices, so that they can rank and act on conservation priorities based on local concerns and opportunities. The experience of implementing conservation action based on the Natural Landscape Assessment and other VCLNA datasets should provide guidance to ongoing development of VCLNA components, as well as examples and inspiration to action for other conservation partners.

- We will continue to coordinate with the development of Blue Infrastructure, seeking to incorporate Blue Infrastructure into the VCLNA and to ensure that Blue Infrastructure protection needs are effectively addressed through the VCLNA.

- We will also work with the Virginia Land Conservation Foundation to help establish the VCLNA as the key planning and performance measure tool for the VLCF.

VCLNA and The Virginia Land Conservation Foundation

The Virginia Land Conservation Foundation (VLCF) was established by the General Assembly in 1999 to help fund the protection of Virginia's natural resources. The foundation makes matching grants to state agencies, local governments, public entities, and nonprofit groups for purchasing fee simple title to and interests in real property for land conservation purposes. The four priority areas are natural area protection, open spaces and parks, historic area preservation, and farmlands and forest preservation.

VLCF, which receives technical support from the Department of Conservation and Recreation, has a broad and ambitious scope and the statutory participation of Virginia's natural resources related agencies. Part of its mandate is to do conservation planning on a statewide basis. VLCF funding was key to creation and maintenance of the Conservation Lands database, and has contributed to the VCLNA as well. The 2004 General Assembly included $2.5 million for VLCF in each of the next two years.

VLCF would like to develop and use VCLNA products to help it lead land conservation activities statewide. VLCF is expected to continue funding the expansion of the VCLNA, including extension of the Natural Landscape Assessment statewide and the acquisition and creation of new datasets for integration into the comprehensive VCLNA. VLCF can then use VCLNA products to assist with the creation of a Strategic Plan and the development of a Decision Support System to identify and prioritize VLCF's conservation targets.

VCLNA and The Virginia Coastal Program Integration Strategy

The ultimate success of many of Virginia's efforts to manage cumulative and secondary impacts to Virginia's Coastal Zone depends on the successful integration of its various regulatory and planning programs. Virginia's Coastal Program is "networked", comprised of many individual programs housed in separate agencies, and coordination and cooperation to achieve common goals is a continuing challenge. For several years Virginia's Coastal Program and Coastal Partners have been pursuing an "Integration Strategy", a means of ensuring a concerted effort to achieve objectives consistent with Coastal Program goals.

There are a number of facets to the Integration Strategy initiative, but the VCLNA will play a key role in bringing state agencies, localities, and other conservation partners together in consistent decision making on a variety of conservation issues. Data assembled for the VCLNA will make available quality information in standardized formats. As a robust GIS model, it can be creatively tweaked to offer practical uses for a variety of needs, and the ability to add data makes it an excellent framework for future development of protection and growth planning tools. The VCLNA products are very attractive and appealing to the public; VCLNA maps will provide an organizational medium for planners to inform and engage the public at a variety of scales. The Virginia Coastal Program seeks a "vision" of what Coastal Partners are working toward. The VCLNA offers just such a graphical vision of conservation status and needs, a visual, attractive way to appeal to, inform, and mobilize the general public in these critical issues.

Request for Feedback

We are interested in feedback of all kinds. Contact the authors to identify any mistakes found, including inconsistencies between the analyses and what's on the ground. We are interested in any improvements that are suggested, whether in the methodology or in the presentation of the products –

this is a complex and ongoing project, with an evolving methodology, and there's plenty of opportunity to make it better. We are also interested in knowing how the data are being used: what projects are using these data or analyses, what additional analyses are being built on this project, and what is being learned that could help other organizations taking conservation actions using the VCLNA.

Updated information about the VCLNA is available at http://www.dcr.state.va.us/dnh/vclna